Azarian J. Agric. VOL (5) ISSUE 1, 2018: 1-6

Azarian Journal of Agriculture

www.azarianjournals.ir

Azarian Journals

Research article ISSN:2383-4420

Effects of different fertilizer sources on growth and yield of broccoli in Chitwan, Nepal

Salina Panta[1*], Purushottam Subedi[2], Roshan Babu Ojha[3], Chandeshwor Prashad Shriwastav[1], Indira Bhattarai[1]

Article Info

Accepted:
19 Feb. 2018

Keywords:
Broccoli, Fertilizer Sources, Soil Organic Matter, Growth, Curd Yield

ABSTRACT

To study the effect of different fertilizer sources on yield, growth and soil organic matter in broccoli, a research was conducted at Agriculture and Forestry University, Chitwan, Nepal from Sep, 2015 to Feb, 2016. The research consisted of ten treatments viz; recommended chemical fertilizer, Farm Yard Manure (FYM), Vermi-compost (VC), Cow urine (CU), Bio organic fertilizer (BOF), (NPK 50%+FYM 50%), (FYM 50% + CU 50%), (FYM 50 % + VC 50%),(FYM 50% + BOF 50%) and {25% (FYM+VC+CU+BOF)} in randomized complete block design replicated three times. The study revealed that the curd yield (10.63 t ha^{-1}), dry matter production (6.34 t ha^{-1}) and leaf area index (5.12) were observed highest at recommended NPK treatment. Among the organic treatments, (FYM 50%+cow urine 50%) combination showed the highest curd yield (7.79 t ha^{-1}), dry matter production (5.49 t ha^{-1}) and leaf area index (4.95). The highest soil organic matter content (2.85 %) was found at (FYM 50%+ VC 50%) treatment and lower (2.06%) was recorded in NPK applied treatment. Thus, the result showed that chemical fertilizer produced the higher yield in first season but the ecological benefits of these fertilizers are relatively less than other organic fertilizers.

INTRODUCTION

Broccoli (*Brassica oleracea* L.var. *italica*) is one of the important vegetables belonging to family Brassicaceae. In Nepal, the total area under broccoli was 2274.8 ha in 2015/16 with the production of 25229.5 mt and productivity is 11.1 mt ha^{-1} (MoAD 2016). Broccoli has high nutritional and good commercial value (Yoldas et al. 2008). It is one of the most important vegetables with abundant vitamins and minerals such as vitamin A and C, carotenoids, fiber, calcium, and folic acid (Paradis, et al. 1995). Broccoli and other brassica vegetables have high content of glucosinolates which has anti-cancer properties (Zhao et al. 2007; Swarup 2012)

Generally, excessive amounts of inorganic fertilizers are applied to the vegetables to achieve a higher yield however the sole use of inorganic fertilizers may cause problems for soil, environment and human health (Naeem et al. 2006). Continuous use of chemical fertilizers adversely affects the texture and structure, reduces organic matter content and decreases microbial activities of soil (Alam et al. 2007). So, application of organic matter to soil is the major concern for maintenance of soil fertility status and crop productivity (Karmegam and Daniel 2000). Organic fertilizers have the capability of supplying a range of nutrients and improving the physical and biological properties of the soil (Chaterjee et al. 2005). Similarly, Gruhn et al. (2000) stated the increased up take of soil NPK, reduction in nutrient losses, and improvement in fertilizer use efficiency due to organic fertilizers.

At present, organic vegetable production is a rapidly growing industry. The increasing concerns over soil quality, pesticide residues in food and the environment has resulted in increased demand for organic food. Organically grown foods are perceived as better quality, healthier and more nutritious than conventional counterparts (Warman and Havard 1997). Organic manure can serve as alternative practice to mineral fertilizers for improving soil structure (Dauda et al. 2008). However, relatively slow mineralization of the composts and other organic fertilizers limits the effective nitrogen utilization (Hartz et al. 2000) and

[1]Agriculture and Forestry University, Rampur, Chitwan, Nepal.
[2] District Agriculture Development Office, Nuwakot, Nepal.
[3]Nepal Agricultural Research Council, Khumaltar, Lalitpur,Nepal.
* E-mail: salina.panta@gmail.com

Table 1. Treatment symbols, combinations and amounts of fertilizers in each treatment.

Treatment symbols and combinations	Amount of fertilizers*
T1: Recommended NPK	137 g urea, 207.67 g DAP, 70.76 g potash
T2: NPK (50%) + FYM (50%)	68.5 g urea, 103.5 g DAP, 35 g potash, 20 Kg FYM
T3: FYM	40 Kg FYM
T4: Vermicompost	11 Kg vermicompost
T5: Cow urine	20 L. cow urine
T6: Bio organic fertilizer (BOF)	9 Kg BOF
T7: 50% FYM + 50% cow urine	20 Kg FYM, 10 L. cow urine
T8: 50% FYM + 50% vermicompost	20 Kg FYM, 5.5 Kg vermicompst
T9: 50% FYM + 50% BOF	20 Kg FYM, 4.5 Kg BOF
T10: 25% FYM + 25% Vermicompost + 25% cow urine + 25% BOF	10 Kg FYM, 2.75 Kg vermicompost, 2.25 Kg BOF, 0.83 L. cow urine

Note: *amounts of fertilizers per plot, urea was applied in two equal splits; first half as basal and second half as top dress at 30 DAT.

hence the low availability of nitrogen contributes low yield in organic farming (Badgley et al. 2007). Judicious combination of organic and inorganic fertilizers might be helpful to obtain a good economic return with good soil health for the subsequent crop. Keeping these points in view the preset investigation was undertaken to study the effects of different organic and inorganic fertilizers on the growth, yield and soil organic matter in Chitwan, Nepal.

MATERIALS AND METHODS

The study was conducted in Agriculture and Forestry University, Rampur, Chitwan (Sep, 2015-Feb, 2016) in randomized complete block design (RCBD) with ten treatments (Table 1) and was replicated thrice. The physico-chemical properties of field soil (30 cm depth) before the experimentation were as presented in the Table 2. Amounts of fertilizers for each treatments were calculated based on recommended dose of fertilizer for broccoli i.e 380:180:80 NPK Kg ha^{-1} (MoAD 2016) and N content of the respective fertilizer (Table 3). Urea was applied in two equal splits first as basal and second as top dress at 30 DAT. In case of cow urine, at first, it was left for two weeks for fermentation and then applied over the soil surface in 7 days interval diluted with water in the ratio of 1:2 (Hamdine 2008; Sharma et al. 2016). Each plot had 5.4 m^2 area with 20 plants planted in 60 * 45 crop spacing.

Data for the various vegetative parameters like leaf number, stem diameter, leaf area index, and dry matter production were recorded. Stem diameter was measured by vernier calliper and simultaneously leaf number per plant was counted in 15 days interval starting from 15 days after transplanting to the first harvest. Similarly, leaf area index (LAI) was taken with the leaf area meter at 60 DAT. For the dry matter production, fresh sample of 100 g was taken and dried in hot air oven at 72^0 C for 72 hrs until constant weight. Curd yield was taken from the sample plants including frequent harvests. Likewise, soil organic matter was measured by the method given by (Walky and Black, 1934) for each plot after the crop harvest.

Table 2. Physico-chemical properties of the soil of the experimental site in Chitwan, Nepal, 2015 (Source: Lab test report)

S.N.	Properties	Average content	Category
1.	Physical properties		
	Sand (%)	72.1	-
	Silt (%)	22.8	-
	Clay (%)	5.1	-
2.	Textural class (USDA textural triangle)	-	Sandy loam
3.	Bulk density	1.41	
4.	Chemical properties		
	Soil pH	6.4	Towards neutral
	Soil organic matter (%)	2.65	Medium
	Total nitrogen (%)	0.14	Medium
	Available phosphorus (Kg ha^{-1})	17.33	Medium
	Available potassium (Kg ha^{-1})	160.8	Medium

Table 3. Nutrient content of different organic fertilizers. (Source: Lab test report)

S.N.	Fertilizers	Nitrogen (%)	Phosphorus (%)	Potash (%)
1	FYM	0.65	0.51	1.05
2	Vermi compost	1.70	0.65	2.66
3	Cow urine	0.90	0.45	1.95
4	BOF	2.0	1.0	1.2

The data collected in the experiment were statistically analyzed with GEN-STAT Version 4.0 statistical software program. Analysis of variance (ANOVA) was done on every measured parameter to determine the significance of differences between means of treatments. Means for each parameter were separated by the Duncan's multiple range test (DMRT) and least significant difference (LSD) at $P \leq 0.05$.

RESULTS AND DISCUSSIONS

Growth parameters of broccoli

The treatments showed significant influence on number of leaves per plant at 45 and 60 DAT (Table 4). But stem diameter was found significantly influenced at 60 DAT only (Fig. 1). The greatest number of leaves per plant was recorded in 50 % recommended NPK + 50 % FYM treatment which remain statistically similar with recommended NPK treatment at 45 and 60 DAT (Table 4). Initially, leaves number per plants from the organic treatments and control were similar but there was gradual increase in difference in leaf number as the recording continued. Similarly, stem diameter remained insignificant among the treatments up to 45 DAT but remained significantly different at 60 DAT (Fig. 1). At 60 DAT, the greatest stem diameter was recorded in recommended NPK treatment which found at par with FYM (50%) + Cow Urine (50%) treatment.

Leaf area index and dry matter production were also found significantly influenced at 60 DAT (Table 5). In case of LAI at 60 DAT, the highest LAI was recorded in recommended NPK treatment (5.12) being statistically at par and followed by FYM (50%) + Cow Urine (50%) (4.95), NPK

(50%) + FYM (50%) (4.93), Cow Urine (4.64) and FYM (50%) + BOF (50%) (4.08). Similarly dry matter production was recorded highest in recommended NPK treatment (6.34 t ha^{-1}) which remained statistically at par with NPK (50%) + FYM (50%) (5.71 t ha^{-1}), FYM (50%) + Cow Urine (50%) (5.49 t ha^{-1}) and bio organic fertilizer (5.31 t ha^{-1}) (Table 5).

The variation in growth pattern between organic and inorganic treatments may be due to nutritional factor mainly. Roe and Cornforth (2000) stated that such variation might be due to the availability of nutrients especially nitrogen and that could be due to the improvement of soil water holding capacity. Greater vegetative growth in the inorganic treatments consisting inorganic NPK may be attributed to its readily available N in high content. Yildirim (2007) also found increased head weight, stem diameter, dry matter production and

Table 4. Effect of different fertilizers sources on number of leaf production of broccoli in Chitwan, Nepal, 2015/16.

Treatments	Number of leaf production per plant			
	15 DAT	30 DAT	45 DAT	60 DAT
Recommended NPK	6.00	10.33	23.89ab	33.39 a
NPK (50%) + FYM (50%)	6.44	11.33	24.61a	35.94 a
FYM	6.44	11.06	19.33bc	21.56 cd
Vermicompost	6.11	10.28	15.39c	17.06 d
Cow Urine	5.94	10.22	15.72c	23.83 bcd
Bio Organic Fertilizer (BOF)	6.50	10.44	17.83c	21.39 cd
FYM (50%) + Cow Urine (50%)	6.11	10.44	19.78bc	25.28 bc
FYM (50%) + Vermicompost (50%)	7.28	11.89	17.06c	18.06 cd
FYM (50%) + BOF (50%)	6.22	11.28	18.17c	20.89 cd
FYM (25%) + Vermicompost (25%) + Cow Urine (25%) + BOF (25%)	6.06	10.44	18.00c	28.27 ab
LSD (0.05)	1.02	1.20	4.58	6.53
SEm (±)	0.34	0.40	1.54	2.19
CV (%)	9.5	6.5	14.1	15.4
Grand Mean	6.31	10.77	18.98	24.67
P value	ns	ns	**	**

Note: Means followed by the same letter(s) in the same column are not significantly different at 5% level of significance by DMRT. 'ns' represents non-significant at 5 % level of significance. **represents significant at 1 % level of significance.

Table 5. Effect of different fertilizer sources on leaf area index and dry matter production of broccoli at Chitwan, Nepal, 2015/16.

Treatments	Leaf Area Index	Dry matter production (t ha^{-1})
Recommended NPK	5.12a	6.34a
NPK (50%) + FYM (50%)	4.93ab	5.71ab
FYM	3.34c	4.69bc
Vermicompost	3.12c	4.33c
Cow Urine	4.64abc	4.83bc
Bio Organic Fertilizer (BOF)	3.57bc	5.31abc
FYM (50%) + Cow Urine (50%)	4.95ab	5.49abc
FYM (50%) + Vermicompost (50%)	3.36c	4.93bc
FYM (50%) + BOF (50%)	4.08abc	4.73bc
FYM (25%) + Vermicompost (25%) + Cow Urine (25%) + BOF (25%)	3.49bc	4.9bc
LSD (0.05)	1.38	1.03
SEm (±)	0.46	0.35
CV (%)	19.8	11.8
P value	*	*

Note: Means followed by the same letter(s) in the same column are not significantly different at 5% level of significance by DMRT.

*represents significant at 5 % level of significance.

plant height of broccoli. Contrastingly, relatively slow mineralization of the composts and other organic fertilizers limits the effective nitrogen utilization (Hartz et. al. 2000). That ultimately influences the growth and yield of the plant. Among the organic sources, FYM (50%) + Cow Urine (50%) treatment had more LAI, number of leaves per plant and dry matter production than others. Organic fertilizer activates soil living microorganisms, which release phyto-hormones and may stimulate the plant growth and absorption of nutrients (Arisha et al. 2003).

Curd yield

There was significant effect of different fertilizer sources on curd yield of broccoli ($p < 0.01$) (Fig. 2). Significantly highest curd yield was observed in recommended NPK treatment (10.63 t ha^{-1}) followed by NPK (50%) + FYM (50%) (8.14 t ha^{-1}) and FYM (50%) + Cow Urine (50%) (7.79 t ha^{-1}). Among the organic fertilizers, FYM (50%) + Cow Urine (50%) showed the maximum curd yield which remained statistically at par with cow urine (6.18 t ha^{-1}) and bio organic fertilizer (6.04 t ha^{-1}) (Fig. 2). The lowest curd yield was observed at FYM (50%) + BOF (50%) treatment (4.56 t ha^{-1}). Organic fertilizers seemed to be less effective in increasing the curd yield of broccoli than inorganic fertilizers. Such results are partially similar with results obtained by (Dufault et al. 2001) on broccoli and Al-Nasir (2002) on cauliflower also. Badgley et al. (2007) stated that low availability of nitrogen in organic fertilizers is the main underlying factor contributing to the low yield in organic farming.

Table 6. Effect of different fertilizer sources on soil organic matter in Chitwan, Nepal, 2015/16.

Treatments	Soil organic matter (%)
Recommended NPK	2.06c
NPK (50%) + FYM (50%)	2.29bc
FYM	2.66ab
Vermicompost	2.72a
Cow Urine	2.45ab
Bio Organic Fertilizer (BOF)	2.77a
FYM (50%) + Cow Urine (50%)	2.70a
FYM (50%) + Vermicompost (50%)	2.85a
FYM (50%) + BOF (50%)	2.83a
FYM (25%) + Vermicompost (25%) + Cow Urine (25%) + BOF (25%)	2.68ab
LSD (0.05)	0.37
SEm (±)	0.12
CV (%)	8.2
P value	**

Note: Means followed by the same letter(s) in the same column are not significantly different at 5% level of significance by DMRT.

**represents significant at 1 % level of significance.

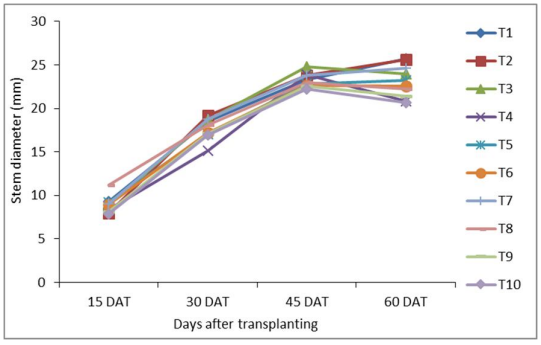

Figure 1. Stem diameter of broccoli as influenced by different fertilizer sources at 15 days interval in Chitwan, Nepal, 2015/16.

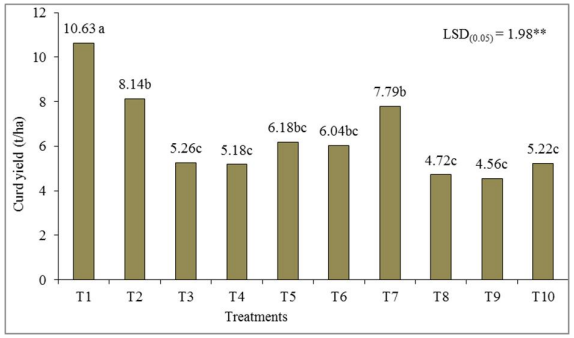

Figure 2. Curd yield of broccoli as influenced by different fertilizer sources in Chitwan, Nepal, 2015/16.

More nitrogen uptake by the broccoli in inorganic NPK treatments had certainly increased the photosynthetic activities in comparison with organic treatments. Organic manures need more time for nutrients release for plant absorption. However, the beneficial effect of organic manure on yield may be due to an increase in organic matter due to the action of decomposition (Wilkinson 1979) and improvement of the soil structure conditions and aeration that encouraged the plant to have a good root development (Arisha et al. 2003).

Soil organic matter (SOM)

Soil organic matter (SOM) was found significantly influenced by the different fertilizer sources (Table 6). The highest SOM was recorded in FYM (50%) + Vermicompost (50%) treatment (2.85 %) which remained statistically similar with all other organic treatments. The recommended NPK treatment had significantly lowest SOM (2.06 %). Here, lower SOM was recorded in the treatments with inorganic NPK application. This showed that FYM, vermicompost, Bio-organic fertilizer, cow urine and their combinations had positive effect on SOM. The application of organic fertilizers has found to maintain or increase the content of organic matter and improve soil fertility (Dêbska et al. 2016). Sharma et al. (2016) also reported the positive effects of FYM and cowurine on soil organic matter over the control treatment in broccoli. Such findings were also reported by (Piaszczyk et al. 2017) in forest nursery soil. They found increase in organic matter by 33 % 40 % in organic fertilizer applied soils in relation to the control soils.

CONCLUSIONS

Among the organic treatments, FYM (50%) + Cow Urine (50%) was the best in relation to curd yield and vegetative growth. Though, inorganic NPK fertilizers consisting treatments showed higher curd yield and vegetative growth as compared to the organic treatments. Likewise, soil organic matter was found higher in organic treatments as compared to the inorganic NPK fertilizers.

ACKNOWLEDGEMENTS

The authors acknowledge the Agriculture and Forestry University, Chitwan and Nepal Agriculture Research and Development Fund (NARDF) for the technical and financial support in conducting the research work.

REFERENCES

Alam M.N. Jahan M.S. Ali M.K. Islam M.S. Khandaker S.M. (2007) Effect of vermicompost and NPKS fertilizers on growth, yield and yield components of red amaranth. Austrian Journal of Basic Applied Science, 1: 706-716.

Al-Nasir F. (2002) Effect of organic fertilizers on yield and nutrients concentration of cauliflower plant. Arch. Acker-Pflanzenbau Bodenkd, 48: 37–47.

Arisha H.M.E. Gad A.A. Younes S.E. (2003) Response of some pepper cultivars to organic and mineral nitrogen fertilizer under sandy soil conditions, Zagazig Journal of Agriculture Research, 30:1875–99.

Badgley C. Moghtader J. Quintero E. Zakem E. Chappell M.J. Avilés-Vázquez K. Samulon A. Perfecto I. (2007) Organic agriculture and the global food supply. Renewable Agriculture and Food Systems, 22:86-108.

Chaterjee B. Ghanti P. Thapa U. Tripathy P. (2005) Effect of organic nutrition in spring broccoli (*Brassica oleraceae* var. *italica* plenck). Vegetable Science. 33 (1): 51-54.

Dauda S.N. Ajayi F.A. Ndor E. (2008) Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application. Journal of Agriculture and Social Sciences, 4: 121–4.

Dêbska B. D³ugosz J. Piotrowska D³ugosz A. Banach-Szott M. (2016) The impact of a bio-fertilizer on the soil organic matter status and carbon sequestration-results from a field-scale

study. Journal of Soils and Sediments, 16: 2335–2343.

Dufault J.R. Korkmaz A. Ward B. (2001) Potential of biosolids from shrimp aquaculture as a fertilizer for broccoli production. Compost Science and Utilization, 9: 107–14.

Gruhn P. Goletti F. Yudelman M. (2000) Integrated nutrient management, soil fertility and sustainable agriculture. Food, Agriculture, and the Environment Discussion, 1-31.

Hamdine S. (2008) Heavy metal traces in potatoes and cabbages fertilized with human urine and composted faeces. M. Sc. Thesis. University of Applied Sciences. Switzerland. 45p.

Hartz T.K. Mitchell J.P. Giannini C. (2000) Nitrogen and carbon mineralization dynamics of manures and compost. Horticulture Science, 35: 209-212.

Karmegam N. Daniel T. (2000) Selected physico-chemical characteristcs and microbial populations of the casts of the worm, *Pontoscolex Corethrurus* (Muller) and surrounding soil in an undisturbed forest floor in SIrumalai Hills, South India. Asian Journal of Microbiology, Biotechnology and Environmental Sciences, 2 (3-4): 231-234.

MoAD. 2016. Agriculture Diary. Agriculture Information and Communication Center. Ministry of Agriculture Development, Kathmandu, Nepal.

MoAD. Statistical information on Nepalese agriculture 2015/16. Agribusiness promotion and statistics division, Singha Durbar: Kathmandu, Nepal.

Naeem M. Iqbal J. Bakhsh M.A.A. (2006) Comparative Study of Inorganic Fertilizers and Organic Manures on Yield and Yield Components of Mungbean (*Vigna radiat* L.). Journal of Agriculture Social Sciences, 2:227–9.

Paradis C. Castaigne F. Desrosiers T. Willemot C. (1995) Evaluation of vitamin C, β-carotene and chlorophyll content in broccoli heads and florets during storage in air. Sciences des Aliments, 15(2): 113-123.

Piaszczyk W. Błoñska E. Lasota J. (2017) Study on the effect of organic fertilizers on soil organic matter and enzyme activities of soil in forest nursery. Soil Science Annual, 68(3), 125-131.

Roe E.N. Cornforth C.G. (2000) Effect of dairy lot scraping and composted dairy manure on growth, yield and profit potential of double-cropped vegetables. Compost Science and Utilization, 8: 320–7.

Sharma R Shah S.C Adhikari K.R. Shah P. Shrestha J. (2016) Effects of cattle urine and FYM on yield of broccoli and soil properties. Journal of AgriSearch 3(3):157-160.

Swarup V. (2012) Vegetable science and technology in India. Kalayani Publishers, New Delhi, pp 370-371.

Walky A. Black I. A. (1934) An examination of the Degtiareff method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Science, 63, 29-38.

Warman P.R. Havard K.A. (1997) Yield, vitamin and mineral contents of organically and conventionally grown carrots and cabbage. Agriculture, Ecosystems and the Environment 61: 155-162.

Wilkinson S.R. (1979) Plant nutrient and economic value of animal manures. Journal of Animal Sciences, 48: 121–33.

Yildirim E. Guvenc I. Turan M. Karatas A. (2007) Effect of foliar urea application on quality, growth, and mineral uptake and yield of broccoli (*Brassica oleraceae* L. var. *italica*). Plant Soil Environment, 53: 120–128.

Yoldas F. Ceylan S. Yagur B. Mordogan N. (2008) Effect of nitrogen fertilizer on yield quality and nutrient content in broccoli. Journal of Plant Nutrition, 31: 1333–1343.

Zhao H. Lin J. Barton Grossman H. (2007) Dietary isothiocyanates, GSTM1, GSTT1, NAT2 polymorphisms and bladder cancer risk. International Journal of Cancer, 120(10): 2208-2213.